

What is claimed is:

- 1 1. A material for absorbing biological fluids, comprising a flexible substrate and an enhanced
2 surface area, said enhanced surface area comprising a multitude of non-hydrolyzable, non-
3 leachable polymer chains covalently bonded by non-siloxane bonds to said flexible substrate;
4 wherein said non-hydrolyzable, non-leachable polymer chains comprise a multitude of
5 antimicrobial groups attached to said non-hydrolyzable, non-leachable polymer chains by
6 covalent bonds; and wherein a sufficient number of said non-hydrolyzable, non-leachable
7 polymer chains are covalently bonded to sites of said flexible substrate to render the material
8 antimicrobial when exposed to aqueous fluids, menses, bodily fluids, or wound exudates.
- 1 2. The material of claim 1, wherein said antimicrobial groups comprise at least one quaternary
2 ammonium structure.
- 1 3. The material of claim 1, wherein said antimicrobial groups comprise at least one non-ionic
2 structure.
- 1 4. The material of claim 3, wherein said at least one non-ionic structure comprises a biguanide.
- 1 5. The material of claim 1, wherein said non-hydrolyzable, non-leaching polymer chains have
2 an average degree of polymerization of about 10 to 100.
- 1 6. The material of claim 1, wherein said material comprises all or part of a wound dressing,
2 sanitary pad, a tampon, an intrinsically antimicrobial absorbent dressing, a diaper, toilet
3 paper, a sponge, a sanitary wipe, isolation and surgical gowns, gloves, surgical scrubs,
4 sutures, sterile packaging, floor mats, lamp handle covers, burn dressings, gauze rolls, blood
5 transfer tubing or storage container, mattress cover, bedding, sheet, towel, underwear, socks,
6 cotton swabs, applicators, exam table covers, head covers, cast liners, splint, paddings, lab
7 coats, air filters for autos planes or HVAC systems, military protective garments, face masks,
8 devices for protection against biohazards and biological warfare agents, lumber, meat or fish

packaging material, apparel for food handling, paper currency, and other surfaces in need of a non-leaching antimicrobial property.

7. The material of claim 1, wherein said flexible substrate is comprised, in whole or in part, of cellulose, or other naturally-derived polymers.

8. The material of claim 1 wherein said flexible substrate is comprised, in whole or in part, of synthetic polymers including, but not limited to: polyethylene, polypropylene, nylon, polyester, polyurethane, or silicone.

9. The material of claim 1, wherein said attachment of said non-hydrolyzable, non-leachable polymer to said flexible substrate is via a carbon-oxygen-carbon bond, also known as an ether linkage.

10. The material of claim 9, wherein a cerium-containing catalyst catalyzes formation of said ether linkage.

11. The material of claim 1 wherein said non-hydrolyzable, non-leachable polymer chains are formed by polymerization of allyl- or vinyl-containing monomers.

12. The material of claim 11 wherein said allyl- or vinyl- monomers are selected from a group consisting of: styrene derivatives; allyl amines or ammonium salts, and the like.

13. The material of claim 11 wherein said allyl- or vinyl- monomers are selected from a group consisting of: acrylates, methacrylates, acrylamides, and methacrylamides.

14. The material of claim 13 wherein said allyl- or vinyl-containing monomers are selected from the group consisting of: compounds of the structure $\text{CH}_2=\text{CR}-(\text{C}=\text{O})-\text{X}-(\text{CH}_2)_n-\text{N}^+\text{R}'\text{R}''\text{R}'''/\text{Y}^-$; wherein, R is hydrogen or methyl, n equals 2 or 3, X is either O, S, or NH, R', R'', and R''' are independently selected from the group consisting of H, C1 to C16 alkyl, aryl, arylamine, alkaryl, and aralkyl, and Y- is an acceptable anionic counterion to the positive

charge of the quaternary nitrogen; diallyldimethylammonium salts; vinyl pyridine and salts thereof; and vinylbenzyltrimethylammonium salts and similar compounds.

15. The material of claim 14 where said allyl- or vinyl-containing monomers are selected from the group consisting of: dimethylaminoethyl methacrylate:methyl chloride quaternary; and dimethylaminoethyl methacrylate:benzyl chloride quaternary.

16. A superabsorbent material for absorbing biological fluids, comprising a flexible substrate and an enhanced surface area, said enhanced surface area comprising a multitude of non-hydrolyzable, non-leachable polymer chains covalently bonded by non-siloxane bonds to said flexible substrate; wherein said non-hydrolyzable, non-leachable polymer chains comprise a multitude of antimicrobial groups attached to said non-hydrolyzable, non-leachable polymer chains by covalent bonds; and wherein a sufficient number of said non-hydrolyzable, non-leachable polymer chains are covalently bonded to sites of said flexible substrate to render the material antimicrobial when exposed to aqueous fluids, menses, bodily fluids, or wound exudates; wherein said superabsorbent material is capable of absorbing about 30 or more times its own weight of water or other fluids in a single instance; and wherein said absorbing capacity is the result of branching or crosslinking of said non-hydrolyzable, non-leachable polymer chains.

17. The material of claim 16, wherein said antimicrobial groups comprise at least one quaternary ammonium structure.

18. The material of claim 16, wherein said antimicrobial groups comprise at least one non-ionic structure.

19. The material of claim 18, wherein said at least one non-ionic structure comprises a biguanide.

20. The material of claim 16, wherein said material comprises all or part of a wound dressing, sanitary pad, a tampon, an intrinsically antimicrobial absorbent dressing, a diaper, toilet paper, a sponge, a sanitary wipe, food preparation surfaces, gowns, gloves, surgical scrubs,

4 sutures, needles, sterile packings, floor mats, lamp handle covers, burn dressings, gauze rolls,
5 blood transfer tubing or storage container, mattress cover, bedding, sheet, towel, underwear,
6 socks, cotton swabs, applicators, exam table covers, head covers, cast liners, splint, paddings,
7 lab coats, air filters for autos planes or HVAC systems, military protective garments, face
8 masks, devices for protection against biohazards and biological warfare agents, lumber, meat
9 packaging material, paper currency, and other surfaces in need of a non-leaching
10 antimicrobial property.

1 21. The material of claim 16, wherein said flexible substrate is comprised, in whole or in part, of
2 cellulose, or other naturally-derived polymers.

1 22. The material of claim 16 wherein said flexible substrate is comprised, in whole or in part, of
2 synthetic polymers including, but not limited to: polyethylene, polypropylene, nylon,
3 polyester, polyurethane, or silicone.

1 23. The material of claim 16, wherein said attachment of said non-hydrolyzable, non-leachable
2 polymer to said flexible substrate is via a carbon-oxygen-carbon bond, also known as an
3 ether linkage.

1 24. The material of claim 23, wherein a cerium-containing catalyst catalyzes formation of said
2 ether linkage.

1 25. The material of claim 16 wherein said non-hydrolyzable, non-leachable polymer chains are
2 formed by polymerization of allyl- or vinyl-containing monomers.

1 26. The material of claim 25 wherein said allyl- or vinyl- monomers are selected from a group
2 consisting of: styrene derivatives; allyl amines or ammonium salts; and the like.

1 27. The material of claim 25 wherein said allyl- or vinyl- monomers are selected from a group
2 consisting of: acrylates, methacrylates, acrylamides, and methacrylamides.
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1 28. The material of claim 27 wherein said allyl- or vinyl-containing monomers are selected from
2 the group consisting of: compounds of the structure $\text{CH}_2=\text{CR}-(\text{C}=\text{O})-\text{X}-(\text{CH}_2)_n-$
3 $\text{N}^+\text{R}'\text{R}''\text{R}'''//\text{Y}^-$; wherein, R is hydrogen or methyl, n equals 2 or 3, X is either O, S, or NH, R',
4 R'', and R''' are independently selected from the group consisting of H, C1 to C16 alkyl, aryl,
5 arylamine, alkaryl, and aralkyl, and Y- is an acceptable anionic counterion to the positive
6 charge of the quaternary nitrogen; diallyldimethylammonium salts; vinyl pyridine and salts
7 thereof; and vinylbenzyltrimethylammonium salts and similar compounds.

1 29. The material of claim 28 where said allyl- or vinyl-containing monomers are selected from
2 the group consisting of: dimethylaminoethyl methacrylate:methyl chloride quaternary; and
3 dimethylaminoethyl methacrylate:benzyl chloride quaternary.

1 30. An inherently antimicrobial composition comprising:
2 a. a substrate; and,
3 b. a coating, layer, or enhanced surface area on said substrate, comprised of a plurality of
4 polymeric molecules of variable lengths bearing antimicrobial groups, wherein said
5 polymeric molecules are covalently, non-leachably bound to said substrate, and wherein
6 said coating, layer, or enhanced surface area exhibits antimicrobial activity due to the
7 presence of said antimicrobial groups.

1 31. The composition of claim 30, wherein said antimicrobial groups comprise at least one
2 quaternary ammonium structure.

1 32. The composition of claim 30, wherein said antimicrobial groups comprise at least one non-
2 ionic structure.

1 33. The composition of claim 32, wherein said at least one non-ionic structure comprises a
2 biguanide.

1 34. The composition of claim 30, wherein said material comprises all or part of a wound
2 dressing, sanitary pad, a tampon, an intrinsically antimicrobial absorbent dressing, a diaper,

toilet paper, a sponge, a sanitary wipe, food preparation surfaces, gowns, gloves, surgical scrubs, sutures, needles, sterile packings, floor mats, lamp handle covers, burn dressings, gauze rolls, blood transfer tubing or storage container, mattress cover, bedding, sheet, towel, underwear, socks, cotton swabs, applicators, exam table covers, head covers, cast liners, splint, paddings, lab coats, air filters for autos planes or HVAC systems, military protective garments, face masks, devices for protection against biohazards and biological warfare agents, lumber, meat packaging material, paper currency, and other surfaces in need of a non-leaching antimicrobial property.

35. The composition of claim 30, wherein said flexible substrate is comprised, in whole or in part, of cellulose, or other naturally-derived polymers.

36. The composition of claim 30 wherein said flexible substrate is comprised, in whole or in part, of synthetic polymers including, but not limited to: polyethylene, polypropylene, nylon, polyester, polyurethane, or silicone.

37. The composition of claim 30, wherein said attachment of said non-hydrolyzable, non-leachable polymer to said flexible substrate is via a carbon-oxygen-carbon bond, also known as an ether linkage.

38. The composition of claim 37, wherein a cerium-containing catalyst catalyzes formation of said ether linkage.

39. The composition of claim 30 wherein said non-hydrolyzable, non-leachable polymer chains are formed by polymerization of allyl- or vinyl-containing monomers.

40. The composition of claim 39 wherein said allyl- or vinyl- monomers are selected from a group consisting of: styrene derivatives; allyl amines or ammonium salts; and the like.

41. The composition of claim 39 wherein said allyl- or vinyl- monomers are selected from a group consisting of: acrylates, methacrylates, acrylamides, and methacrylamides.

42. The composition of claim 41 wherein said allyl- or vinyl-containing monomers are selected from the group consisting of: compounds of the structure $\text{CH}_2=\text{CR}-(\text{C}=\text{O})-\text{X}-(\text{CH}_2)_n-\text{N}^+\text{R}'\text{R}''\text{R}'''//\text{Y}^-$; wherein, R is hydrogen or methyl, n equals 2 or 3, X is either O, S, or NH, R', R'', and R''' are independently selected from the group consisting of H, C1 to C16 alkyl, aryl, arylamine, alkaryl, and aralkyl, and Y- is an acceptable anionic counterion to the positive charge of the quaternary nitrogen; diallyldimethylammonium salts; vinyl pyridine and salts thereof; and vinylbenzyltrimethylammonium salts and similar compounds.

43. The composition of claim 42 where said allyl- or vinyl-containing monomers are selected from the group consisting of: dimethylaminoethyl methacrylate:methyl chloride quaternary; and dimethylaminoethyl methacrylate:benzyl chloride quaternary.

44. The antimicrobial composition of claim 43, wherein said substrate is a woven or nonwoven flexible matrix, and said composition is formed into the shape of a wound dressing.

45. The antimicrobial composition of claim 43, wherein said coating absorbs aqueous liquids.

46. The antimicrobial composition of claim 43, wherein said substrate is wood, lumber, or an extract comprising or a derivative of wood fiber.

47. A method for the preparation of a non-leaching antimicrobial-coated composition, comprising the steps of:

- immersing all or a portion of a substrate into a solution comprising a sufficient quantity of monomer bearing at least one antimicrobial group per monomer molecule, and a sufficient quantity of catalyst, to sustain polymerization reactions to sufficiently coat said substrate to impart an antimicrobial characteristic;
- maintaining the contact of said substrate with said solution under acceptable conditions for a sufficient period of time to complete said reaction, wherein said reactions comprise forming polymers of varying lengths, and forming covalent, non-siloxane bonds between the majority of said polymers of varying lengths and binding sites on said substrate.

- 11 c. rinsing said substrate sufficiently to remove non-polymerized monomer molecules, non-
12 stabilized polymer molecules, and catalyst; and
13 d. drying said substrate to a desired low moisture content, such that the substrate is not a
14 hydrogel.

1 48. The method of claim 47, additionally comprising the step of maintaining the solution and
2 gases in contact with the solution free of oxygen by sparging with an inert gas.

1 49. The method of claim 47, in which said rinsing is with an aqueous solution, and additionally
2 comprising the step of dewatering the substrate after the rinsing step.

1 50. The method of claim 47 wherein the catalyst is a cerium salt.

1 51. An antimicrobial-coated composition for destruction of microbes contacting said
2 composition, comprising:

- 3 a. a substrate onto which a coating of antimicrobial polymers is bonded; and,
4 b. said coating, formed of an effective amount of polymeric molecules having a multiplicity
5 of quaternary ammonium groups, wherein said polymeric molecules are non-leachably and
6 covalently bonded to surface sites of said substrate, wherein said polymers do not form using
7 siloxane bonds, and wherein said coating is absorbent of aqueous liquids,
8 whereby said multiplicity of quaternary ammonium groups act to destroy microbes coming in
9 contact with said groups.